Swedish Metrology and Quality AB

Accred. no. 10436
Proficiency testing
ISO/IEC 17043

To participants

Report on an interlaboratory comparison (ILC Angle 2023:1) of the calibration in the angle area.

The case carrying the equipment for calibration.

Weight 2 kg

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Content

Purpose and implementation of the comparison

This interlaboratory comparison serves as a tool to verify results from the measurement carried out by calibration laboratories. It is an effective method to demonstrate technical capacity of the participant and serves as a technical base for accreditation as required by ISO/IEC 17025:2017 (SS-EN ISO/IEC 17025:2018) as specified in point 7.7.2.

This report is covering the results related to angle calibrations.

Advisory group

The intercomparison has followed the recommendations of the advisory group. The advisory group has defined the instrument that should be included in this ILC as well as the choice of measuring points that are defined to be included in the evaluation of the results.

The members of the advisory group are Mikael Frennberg, Quality Control in Metrology Sweden, Peter Lau MNE konsult and Håkan Källgren SMQ.

Information about the intercomparison

The information about the intercomparison was given in 3 different media:

- Linkedin
- The data base https://www.eptis.org
- On the web https://smquality.se/interlaboratory-comparisons-ilc

The information on the web was done in 2 steps. General information as ILC Length 2021:1 referred to in annex 1 in this report.

Detailed information as a description of the intercomparison/ILC published on smquality.se and enclosed as annex 2 in this report.

The calibrated equipment

Participating laboratories and measuring scheme for the comparison

Laboratory
VTT MIKES Finland reference laboratory
Teknologisk Institut
esz AG

The participants have an accreditation by DANAK and DAkkS.

Principles on the calibration in general

The reference laboratory calibrated the equipment prior to the calibrations by the first participant.

The organiser made a preliminary follow up after each individual calibration by the participants to find out if there were some problems on the objects. The main purpose for doing so was to achieve as equal conditions as possible for all participants.

Conditions and transport during the measurement period

A special case having special filters and insulation for humidity and vibrations was used for the transportation.

Calibration instructions

The laboratories were allowed maximum 5 days for the calibration.

In the call they were advised to use their own calibration procedures with focus on the points that were important for the inter-comparison outcome. They were not allowed to perform any type of adjustment on the objects.

The laboratories further were encouraged to use their calculated uncertainty values even if those would differ from the CMC values in their accreditation.

Compulsory calibration points

The participant should calibrate according to the following parameters / measuring points on the objects:

Measuring point / °		Measuring point / °
-10		-90
-8		-60
-6		-30
-4		0
-2		30.0
0		60.0
2		90.0
4		
6		
8		
10		

The participant was allowed to record other points as described in their method and issue calibration certificates according to their method. However, the comparison was only evaluated and executed in the points (parameters) mentioned above.

Planning and instruction details

The laboratories were asked to send original calibration data in pre-defined forms (enclosed in annex 3) in digital form as PDF files or excel files by e-mail before transporting to next laboratory. The final calibration certificate should then be sent to the organizer within one week.

The evaluator used the principles of the ISO/IEC 17043:2010 in the reporting.

The participants should deliver calibration certificates, which at least stated the measured values together with a belonging uncertainty for the points stated above.

It was possible to provide additional information or supplementary documentation eventually needed to understand the results.

Administrative information

Address to send the required documents:
Swedish Metrology and Quality AB Håkan Källgren Dragspelsgatan 21 SE-504 72 Borås, Sweden e-mail: hakan.kallgren@smquality.se Phone: +46705774931

Summary of the timeline planning in the call:

- The preliminary results should be sent to the organiser when the parcel was sent to next participant.
- One week after the calibration/measurement send the calibration certificate to the evaluator of the intercomparison.
- A draft report should be sent to the participants 2 weeks after receiving the last calibration certificate.
- Comments on the draft report to the organiser within 1 week
- Final report should be finalized within 2 weeks after receiving comments from all participants.

Report

Considering 2 laboratories from 2 different countries the following up of eventual drift based on the preliminary results was indicating that the object was stable.

Analysis of the calibration results

Along with each correction all participants delivered their estimated measurement uncertainties U_i and so did as well the reference laboratory VTT Mikes. The reference uncertainty U_{ref} is defined as uncertainty by Rise plus half of the eventual difference found over the time of the measurements.

$$En = \frac{|c_i - c_{ref}|}{\sqrt{U_i^2 + U_{ref}^2}}$$

For each calibrated point

c_i: Single measurement result, index i counts the various participants.

c_{ref}: Reference value for comparison – provided from reference laboratory.

U_i: The estimated expanded uncertainty (k=2) stated by each laboratory

U_{ref}: The estimated expanded uncertainty (k=2) of the reference value

The expression in the denominator is a measure for the uncertainty in the difference in the nominator.

For an acceptable result the En-value should not exceed the value of 1.

Traceability for the reference values R1 and R2 at each point

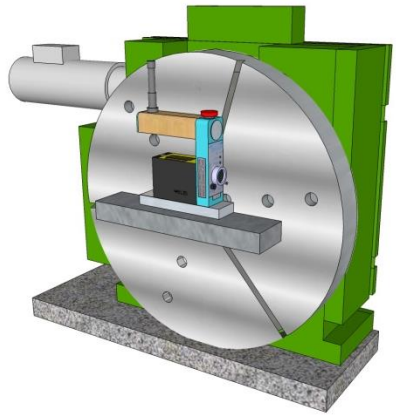
The traceability for the reference laboratory VTT Mikes is established by regular calibrations of the laboratory's standards traceable to the realisation of angle in the SI-System.

The results from calibration of the equipment at the reference laboratory are documented in the following calibration certificate.

Calibration certificate at the reference laboratory M-24L001

Explanation of the calibrations at the reference laboratory

The reference plane of a vertical rotary table was set to zero inclination by reversal measurement with Wyler Minilevel NT clinometer. Clockwise direction was chosen as positive direction. The device under test (DUT) was fixed to reference plane and rotated from -180° to 180° and back. The values at measuring points were recorded just after the change of the last digit of the DUT to nominal value. The results are averages of CW and CCW direction readings.



Results

The following tables list the results from the participants.

Table 1. Reported values at measurement points -10° to 10°. (Lab 1)

Angle°	Reference°	Measured°	Error°	Uncertainty°	Error, reference laboratory°	Uncertainty, reference laboratory°	En-value
-10	9,97	10,00	0,03	0,1	-0,092	0,040	1,13
-8	7,93	8,00	0,07	0,1	-0,081	0,040	1,40
-6	5,95	6,00	0,05	0,1	-0,058	0,040	1,00
-4	3,96	4,00	0,04	0,1	-0,067	0,040	0,99
-2	2,03	2,00	-0,03	0,1	-0,069	0,040	0,36
0	0,00	0,00	0,00	0,1	-0,052	0,040	0,48
2	2,17	2,00	-0,17	0,1	-0,034	0,040	1,26
4	4,14	4,00	-0,14	0,1	-0,075	0,040	0,60
6	6,08	6,00	-0,08	0,1	-0,044	0,040	0,33
8	8,07	8,00	-0,07	0,1	-0,099	0,040	0,27
10	10,15	10,10	-0,05	0,1	-0,060	0,040	0,09

Table 2. Reported values at measurement points -10° to 10°. (Lab 2)

Angle°	Refe-rence°	Measured°	Error°	Uncertainty°	Error, reference laboratory°	Uncertainty, re-ference labora-tory°	En-value
-10	10,000	10,00	0,00	0,058	-0,092	0,040	1,31
-8	8,000	8,00	0,00	0,058	-0,081	0,040	1,15
-6	6,000	6,00	0,00	0,058	-0,058	0,040	0,82
-4	4,000	4,00	0,00	0,058	-0,067	0,040	0,95
-2	2,000	1,90	-0,10	0,058	-0,069	0,040	0,44
0	0,000	0,00	0,00	0,058	-0,052	0,040	0,74
2	2,000	2,00	0,00	0,058	-0,034	0,040	0,48
4	4,000	4,00	0,00	0,058	-0,075	0,040	1,06
6	6,000	6,00	0,00	0,058	-0,044	0,040	0,62
8	8,000	8,10	0,10	0,058	-0,099	0,040	2,82
10	10,000	10,00	0,00	0,058	-0,060	0,040	0,85

Table 3. Reported values at measurement points -90° to 90°. (Lab 2)

Angle°	Refe-rence°	Measured°	Error°	Uncertainty°	Error, reference laboratory°	Uncertainty, re-ference labora-tory°	En-value
-90	90,000	90,0	0,00	0,058	-0,078	0,040	1,11
-60	60,000	60,0	0,00	0,058	-0,080	0,040	1,14
-30	30,000	30,0	0,00	0,058	-0,081	0,040	1,15
0	0,000	0,0	0,00	0,058	-0,052	0,040	0,74
30	30,000	30,0	0,00	0,058	0,007	0,040	0,10
60	60,000	60,0	0,00	0,058	0,033	0,040	0,47
90	90,000	90,0	0,00	0,058	0,048	0,040	0,68

Final conclusions

In this inter comparison the two participants could demonstrate a capacity to calibrate the object in this ILC even if some results are above the En value 1.

The ability of different laboratories to prove the correctness of their CMC values is not a part of an intercomparison of this type. It is up to the various laboratories to evaluate their results according to the requirements in ISO/IEC 17025:2017 as specified in point 7.7.3.

Additions to the DRAFT report

Some editorial changes.

En-values are reported as absolute values.

Explanation of the reference calibrations is added.

Acknowledgement

We gratefully thank the member of the advisory board and expert in length calibrations Mikael Frennberg.

We also acknowledge the primary calibrations by VTT Mikes Finland that supported the ILC with reference calibrations.

Annex 1 ILC Length 2021:1 published on www.smquality.se

Annex 2 Revised description of the intercomparison/ILC published on www.smquality.se

Annex 3 reporting form for preliminary calibration results.

Table 2. Example of results tables.

Measuring point / °	Reference angle / °	Direction from level	Measured inclination angle, DUT / °	Deviation from reference / °	Expanded Uncertainty / °
-10		-	*10.0*		
-8		-	*8.0*		
-6		-	*6.0*		
-4		-	*4.0*		
-2		-	*2.0*		
0			*0.0*		
2		+	*2.0*		
4		+	*4.0*		
6		+	*6.0*		
8		+	*8.0*		
10		+	*10.0*		

Measuring point / °	Reference angle / °	Direction from 0	Measured angle, DUT / °	Deviation from reference / °	Expanded Uncertainty / °
-90		-	*90.0*		
-60		-	*60.0*		
-30		-	*30.0*		
0			*0.0*		
30.0		+	*30.0*		
60.0		+	*60.0*		
90.0		+	*90.0*		

References:

- ISO/IEC 17043:2023 Conformity assessment – General requirements for proficiency testing
- ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories
- ISO 13528 Statistical methods for use in proficiency testing by interlaboratory comparison.
- Evaluation of measurement data – Guide to the expression of uncertainty in measurement, GUM (JCGM 100:2008)
- EA-4/02 M:2013 Evaluation of Uncertainty of Measurement in Calibration
- International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)